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ABSTRACT

Extended hospital stay after medical treatment has been completed represents a major problem in health care. Space misuse can occur late in the hospitalization, often because planning is not initiated until discharge is imminent. This study sought to determine if variables assessed soon after hospital admission could be used to screen patients at risk for readmission, placement, or long hospital stay. Variables reported in the literature were used to screen patients (N=532) 2 days after admission for risk of negative outcome. Risk factors that significantly related to readmission, placement, or lengthy hospital stay included two or more chronic medical conditions, living alone or being admitted from a nursing home, dependent ambulation, poor mental status, psychiatric comorbidity, prior admission within the past 2 months, age over 75, and no source of income. Using these criteria, an index was developed to determine risk for placement, readmission, or lengthy stay. The high risk index could optimally identify poor outcome in 95% of the 532 cases screened. Use of cumulative risk scores can result in accurate prediction of outcome and may be useful in targeting patients for intervention. Since the index was developed at a veteran's medical center, performance of the index should be determined based on where it is to be used. (Author/ABL)

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NON-DISEASE SPECIFIC RISK FACTORS AFFECTING HOSPITAL OUTCOME

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NON-DISEASE SPECIFIC RISK FACTORS AFFECTING HOSPITAL OUTCOME

Abstract-Purpose of the current study was to determine if variables identifiable near hospital admission could be used to effectively screen patients at risk for poor outcomme. Variables reported in the literature were used to screen patients 2 days after admission for risk of negative outcome. Risk factors significantly related to readmission, placement or long hospital stay included: two or more chronic medical problems, substandard premorbid living arrangements, dependent ambulation, poor mental status, comorbid psychiatric condition, prior admission within the past 2 months, age over 75, and no source of income. Subsequently, a high risk index was developed that could optimally identify poor outcome in 95% of the 532 cases screened. The index allows discharge planners to adjust the critical risk score depending on the sensitivity and specificity desired in the prediction model.

NON-DISEASE SPECIFIC RISK FACTORS AFFECTING HOSPITAL OUTCOME

Continued hospitalization of patients after their medical treatments have been completed represents a major misuse of health care resources. Misuse can occur late in the hospitalization, often because planning is not initiated until discharge is imminent. Last minute discharge planning to conserve space can result in unnecessary readmission or nursing home placement.[1,2] These observations support the opinion that early case finding and intervention with patients at risk for poor outcome could lead to reduced costs or improved care.

Purpose of the current study was to determine if variables identifiable near hospital admission could be used to screen patients who were at risk to become high users of health care resources. High risk case management has the potential for planning, providing, and coordinating services that are not under the direct costs to the hospital. Some studies have demonstrated remarkable effectiveness of discharge planning efforts.[3] For instance, Berkman et al.[4] were able to show that, among patients brought to the attention of social workers near admission, those who ultimately needed help in seeking a placement were discharged ten days sooner. An important implication of much health care use research is that hospitalization is not based solely on medical characteristics, and thus casefinding using a variety of health and personal characteristics may be used to promote good outcome.[5]

Even though administrators often try to serve those most in need through better casefinding, cost may prohibit the provision of comprehensive, timely discharge planning with all patients. A

more practical approach to conserving hospital resources is to target service to patients at risk for poor outcome. A major deterrant to such a risk screening effort, however, has been lack of easily obtained, measurable outcome predictors. Few methodologically sound studies have been completed that evaluate benefits of such risk triage, with some exceptions.[6] Inui,[7] using Glass' CAAST Index,[8] was able to predict which patients needed planning for special dispositions such as nursing home placement.

Berkman et al.[9] reviewed recent studies that have tried to improve casefinding for hospital patients with resilient social problems. They note that diagnostically focused approaches screen in too many patients, whereas instruments relying on sociodemographic variables do not account for a majority of risk variance. A decision-making methodology with predetermined criteria that uses reliable and valid screening variables would be more specific than current efforts and should logically lead to more accurate casefinding.

Our objective was to develop a non-disease specific risk screening protocol that could be used to plan better discharges or followup care for patients early in their hospitalization. Demonstration projects suggest that quantity of health services used are not explained by standard economic variables, ergo demand can potentially be somewhat controlled by the provider.[10] Consistent with these findings, the main impact of early casefinding has been both prevention of health problems and reduction in unnecessary services.[11]

METHOD

Procedure.

During a two month period in Summer 1987, records of patients admitted to medical, neurological, & surgical wards of SVAMC (n = 709) were screened by research staff. Independent variables were collected by review of medical and nursing records the second day after patient admission. Multivariate analyses were completed by stepwise multiple logistic regression, using the 17 variables against a dummy outcome variable, any negative outcome. Any negative outcome was defined as readmission within 60 days, placement in a nursing home directly from the hospital, or a stay longer than the average for the respective DRG. One-fourth of the subjects (n=177) were reserved for a validation group. The functions for predicting risk for negative outcome were derived from the analysis group and then tested on the validation group.

Risk Factors

Literature search of databases for gerontological and health services research over the past ten years was conducted to identify studies that differentiated risk for hospital admission, nursing home placement, or lengthy hospital stay. We excluded small sample case studies and disease specific reports. For instance, alcohol abuse,[12] insurance coverage,[13] and leg amputation[14] were not included because study findings were based on uncontrolled trials, small samples, or were disease specific.

Many studies purporting to evaluate risk for negative hospital outcome were methodologically unsophisticated. Some presented isolated cases as proof of risk, and others used outcome data based on estimates of treatment effects, which biased the outcome

measure. The task of summarizing the results of these research efforts has been controversial because of variations among the studies in types of outcomes evaluated and differing methodological approaches used. Table 1 lists the variables which were significant in differentiating high use patients in one or more of the studies reviewed.

(Insert Table 1 about here)

Dependent variables were included in the study if they were identified in the literature search as being able to differentiate at least one of the negative outcomes. We were interested only in variables that could be reliably collected from medical records early in the hospital period with a minimum of clinical interpretation. For this reason, scales of functional ability and mood were not considered. Some functional assessments have purportedly been used as screening mechanisms in their own right,[14] but there is no common language for defining variables across studies.[15] Education level and number of medications were excluded from our analysis because data were not readily available. Gender was excluded from analysis because lesser than 4% of the sample were female. The variables 'no place to live' and 'admit from nursing home' were combined, i.e., living arrangements, in order to make categories mutually exclusive. Descriptive data are listed in Table 2.

(Insert Table 2 about here)

Study variables selected from literature review were dichotomous responses to the following inquiries: Over age 75, unmarried, no source of income, prior admit within 60 days of admission, living arrangements (no place to live or admit from a

nursing home), dependent ambulation (unable to walk or wheel chair without assistance), poor mental status (not oriented to person, time, and place), terminal illness, comorbid psychiatric disorder, 2 or more chronic conditions, dependent self care (any dependence in feeding, dressing, or bathing), incontinence, dysphasia, social support (next of kin listed), employment and emergency admit. Chronicity was determined with guidelines suggested by Anderson.[16] Hospital service was included in the analysis to control for baseline effects. To establish reliability of the data collection protocol, the two research assistants collected data from the same records for 30 randomly selected patients. Item agreement was 91%.

Rationale behind the risk screening effort was that if information could be identified by the second day after hospital admission, then it may be useful in targeting patients at risk for negative outcome. The second day was chosen as a time frame for identification because it is the typical low trim point for most DRG's and allows time for staff to chart their clinical evaluations. The average length of stay in the hospital during the quarter prior to the study was 12.2 days. Thus second day screening would permit more than a week planning time for an average patient.

Outcome Measures

Hospital outcome can be judged in a variety of ways, e.g. whether cause of admission was resolved, if the individual's perceived health status improved as a result of treatment; or in terms of survival rates, length of stay, recidivism, or need for long term care. We measured hospital use in terms of negative

outcome, i.e., hospital readmission within 60 days, nursing home placement, or greater than expected length of stay.

Our readmission time frame corresponds to the spell of illness definition used by the Medicare program, and was patterned after Anderson,[16] who considered that readmission within two months represents the best criteria for identifying preventable problems. We counted transfers to other facilities as readmissions, which is a qualitative decision effecting only 1.3% of the sample and likely did not have a major impact on the findings. Nursing home placement was defined as direct admission to a long term care facility, either skilled or intermediate care, but not to congregate care, such as a boarding home or retirement center.

A lengthy stay was any hospitalization greater than that expected by DRG guidelines. Thus, we chose not to limit anaylsis to merely DRG outliers. A major purpose of this study was to develop a screening program that would be useful in preventing long stays. Limiting the study to only the DRG outliers would have meant targeting lesser than 20% for evaluation of lengthy stay. Persons staying an average time might also benefit from intervention.

Incidence of readmission was interpolated from hospital records, and non-SVAMC admissions were identified with followup phone calls to patients or relatives. Length of stay and placement data were readily available from the hospital information system.

RESULTS

Twenty one percent of the patients were readmitted within 60 days and 9% were placed directly into nursing homes at discharge. Mean length of stay for the sample was 12.23 days (sd = 11.4). Lesser than 70% of 'at risk' patients were seen by a caseworker for discharge planning purposes, and, of those who were seen, the average time from admission to social service consult was 6.4 days. Eight variables significantly discriminated negative outcome using discriminant analysis, $F(7,523) = 17.83$, $p<.01$; i.e., ambulation, age, mental status, chronicity, living arrangements, pscychiatric comorbidity, prior admission, and no source of income.

Table 3 lists the univariate association of statistically significant independent variables by type of outcome. Having 2 or more chronic conditions was the most effective discriminator of outcome. A goodness of fit chi-square log likelihood was computed based on stepwise logistic regression, and the 8 variables collectively accounted for a significant amount of variance (Table 4) in the analysis group. The discriminant analysis was then applied to the 177 patients who were reserved for validation. The classification success in the validation group was lower than that in the analysis group. The overall classification success dropped from 73.4% to 71.2%, suggesting that approximately 2.2% of the classification success in the analysis group may be due to the bias inherent in classifying the same sample from which the function was derived.

(Insert Tables 3 & 4 about here)

Risk Screening Index

The 8 discriminant variables were used to develop a High Risk Index by adding number of negative indicators for each patient, resulting in indices ranging from 0-8 (Table 5). To identify patients for early discharge planning, a risk threshold needs to be identified, e.g., a score above which a patient should be referred for intervention. Ideally, scores would differentiate patients who need help from those who do not. Classification errors are of two types: incorrect identification of patients with poor outcome, i.e., false positives; and incorrect identification of patients with good outcome, i.e., false negatives. (Insert Table 5 about here)

Patients above a critical score who had a poor outcome are 'true positives.' Patients below a specific threshold who, in fact, did not have a poor outcome are 'true negatives.' Number of correct classifications for any index score can be examined in a two by two table format, and decisions can be made regarding the screening potential of each score, using an agreement percentage measuring predictive power of the index.

Table 6 exemplifies a contingency table for a critical score of 4. All of the test performance characteristics illustrated were calculated for each index score. Using a threshold of 4 yielded the highest agreement percentage and thus maximizes the identification of patients at risk for poor outcome. However, a critical score of 4 results in over 40% of patients being targeted for intervention, which may exceed the response capabilities of some hospitals. Using a critical score of 5 (Table 7) results in a less sensitive, but more specific, index

which identifies 21% of patients as at risk.

(Insert Tables 6 & 7 about here)

DISCUSSION

By applying multivariate logistic regression analysis to a sample of hospital patients, we identified a number of risk factors for readmission, nursing home placement, or lengthy stay. Nature of the predictive variables were medical, psychiatric, and social. The most important application of the prediction model may be for identifying patients at risk for poor outcome early in their hospitalization. Attention to the 8 factors can result in a range of predicted probability of poor outcome for an individual patient from as low as .18 to greater than .95. Strategies for intervention can be based on sensitivity and specificity of the criteria scores as they relate to potential volume of patients perceived as at risk.

This exploratory study necessarily has a limited focus. Discharge planning involves much more than trying to prevent a negative outcome as we defined it. A complex educational, counseling, and resource facilitation effort hopefully improves quality of life beyond a count of readmissions or placements. And social service caseworkers certainly see patients for more than discharge planning issues.

However, if facilitating discharge is a priority, referral by consultation for help in planning could be improved with use of a risk screening protocol. Less than 70% of patients who ultimately had a negative outcome were seen by a social worker in the current study. This finding supports Inui et al.'s[7] observation: "a major problem for social workers and others

involved in discharge planning has been their relative inability to identify patients in need of special planning efforts early in the course of hospitalization." Serving persons who are known to be most in need is one means of increasing hospital efficiency where there is substantial agreemen.[17]

It is therefore encouraging that a risk screening index may be useful in targeting patients for service. To implement such a screening process, staff time would need to be allocated for review of records. On the other hand, all of the significant risk factors are relatively easy to collect at or near admission, and some, such as age and source of income, are readily available. Perhaps additional research can simplify the screening procedure or weigh the cost benefit of triaging for discharge needs. Ability to choose the threshold of risk in targeting services to clients most in need may offset these technical costs per more efficient deployment of resources.

Since we used the same sample for both developing the model and in testing its performance, additional trials may help make results applicable to other settings. Also, psychometric properties of the risk index are a function of variations in the prevalence of the characteristics under study. Therefore, performance of the risk index should be determined based on data from the population under study.

Several studies have made recommendations for structuring discharge planning programs, e.g., using a social worker to coordinate team approaches,[18] training staff to refer early,[19] or involving social workers in difficult cases.[20] Considering these

suggestions, the risk screening method described seems to meet two objectives of early discharge planning: 1) to maximize the number of patients requiring help with disposition or referral for social service evaluation, and 2) to minimize the number of inappropriate referrals.

The practical benefits of risk screening need to be tested in a controlled study to evaluate whether intervention might be helpful for the 'at risk' group. Such a demonstration project would indicate whether readmission rates, placements, and lengthy stays could be impacted. The extent to which the predictive power of the model could be improved should also be explored. Particularly, since our sample was comprised entirely of military veterans, other populations may have characteristics which require alternate risk factors or a different methodological aproach.

SUMMARY

We reviewed the literature for variables that could be reliably obtained at or near hospital admission. A number of studies have noted variables that identify patients at risk for nursing home placement, and others have isolated clinical information which correlates with lengthy hospital stay and readmission. We attempted to collate findings of prior hospital use research and develop an index to predict risk for negative hospital outcome. Developing a reliable risk screening protocol is a necessary step in evaluating whether early discharge planning is a viable means of reducing hospital costs and improving outcome. A handful of variables do appear useful in predicting outcome, but they may not be applicable to all

hospital settings and may vary over time.

In future research, we plan to use the 8 criteria variables to select high risk patients and evaluate whether or not early referral to social work can effectively impact outcome. Using a risk index cutoff score of 5, about 20% of patients will be targeted for discharge planning. Based on the current study results, over 75% should be correctly identified as at risk for a negative outcome, and thus, we hypothesize, may benefit from early discharge planning.

Table 1. Risk Factors Affecting Hospital Outcome by Study.

Study Reference	TYPE OF OUTCOME EVALUATED * Lengthy Stay	Readmission	Placement
(16) Anderson		1,5	
(21) Andrews		6	
(22) Arling	11		11,26
(23) Barsky		1,14,16	
(24) Beland			4,8,17,19
(25) Branch			10,26
(1) Cohen			1
(26) Dowd	4,7,17,24		
(6) Fehtke		1,3,5,6,8,18	
(27) Fulop	14		
(8) Glass	1,7,8,9,10,18		
(28) Greenberg			12,16
(7) Inui			1,7,8,9,21
(29) Jones	2,3,5,16		
(30) Kessler		14	
(31) Lamont			20
(32) Lewis	3	3	
(33) Lewis			10,12
(34) Liu			1,3
(35) Marchette	4,16		
(36) Mason		15,20	
(37) McCoy	6		1,6,12
(38) Palmore			3,4,6,19
(39) Roos	10,16,19	10,16	
(40) Shapiro		2,8	
(41) Shapiro		13	
(17) Weissert			3,10,12
(42) Weinberger		14	14
(43) Zook	13	5,13	

*Variables which significantly differentiated type of outcome in the studies cited: 1=age, 2=type of admission, 3=marital status, 4=income source, 5=prior admission, 6=lives alone, 7=dependent ambulation, 8=admit from nursing home, 9=incontinent, 10=mental status, 11=dysphasia, 12=self care, 13=terminal, 14=comorbid psychiatric condition, 15=employment, 16=chronic conditions, 17=medications, 18=gender, 19=education, 20=social support

Table 2. Sample Description (n = 532)

Variate	Incidence (% rounded)
over age 75	31 (mean=60.8 +/- 12.7)
married	71
employed	34
discharged by service	
medicine	49
surgery	26
neurology	24
Primary admitting diagnosis	
DRG 9-99	24
DRG 100-189	34
DRG 202-297	22
DRG 316-399	12
DRG 403-467	8

Table 3. Proportions for dependent variables (% rounded)

	Negative Outcome (n = 226)	Positive Outcome (n = 306)
1 2+ chronic conditions	56	24
2. living alone or admit from nursing home	42	16
3. dependent ambulation	17	9
4 comorbid psychiatric dx	23	7
5. prior admission	32	16
6. poor mental status	21	5
7. over age 75	37	23
8. no source of income	17	4

Table 4. Predictors of risk for negative hospital outcome: Results of multiple logistic regression analyses.

Variable	Any negative Outcome B	Any negative Outcome se	Nursing Home B	Nursing Home se	Long Stay B	Long Stay se	Readmission B	Readmission se
2+ chronic conditions	.52a	.24	.02	.10	.04	.07	.36a	.21
living arrangements	.49a	.24	.21b	.19	.01	.13	.09	.12
dependent ambulation	.43a	.26	.35a	.21	.32a	.21	.15	.14
comorbid psychiatric dx	.31a	.33	.07	.15	.43a	.23	.03	.08
prior admission	.27a	.22	.09	.20	.05	.09	.42a	.31
poor mental status	.25a	.29	.11	.06	.30a	.25	.13	.11
over age 75	.22a	.26	.28a	.31	.26b	.22	.01	.06
no source of income	.19a	.29	.23b	.17	.16	.17	.14	.10
N	523		527		525		523	

a = p<.01
b = p<.05

Table 5.
Distribution of Patients by High Risk Index Score (N=532)

Distribution	High Risk Index Score 0-1	2	3	4	5	6	7-8	Total
Number with score	100	102	114	104	62	34	16	532
Number with poor outcome	11	13	28	76	56	30	12	226

Table 6. Prediction of poor hospital outcome using a High Risk Index Critical Score of 4.

Risk Index Score	Actual Patient Outcome*	
	Negative	Positive
5 or more = high risk, likely negative outcome	174(TP)	42(FP)
<5 = low risk, likely positive outcome	66(FN)	250(TP)

*TN=true negative, FN=false negative, FP=false positive, TP=true positive. Sensitivity = .72 Specificity = .85 Agreement percentage = .79

An **agreement percentage** is the sample proportion accurately assessed as likely to have a poor outcome. It is calculated by adding the number of 'true positives' and 'true negatives' and dividing by the total number of cases. The predictive power of the positive test for an individual score is the probability that patients identified as at risk for poor outcome will in fact have a poor outcome. It is calculated by dividing 'true positives' by the sum of 'true' and 'false' positives.

Table 7. Prediction of poor hospital outcome using a High Risk Index Critical Score of 5.

Risk Index Score	Actual Patient Outcome*	
	Negative	Positive
5 or more = high risk, likely negative outcome	98(TP)	14(FP)
<5 = low risk, likely positive outcome	128(FN)	292(TP)

*TN=true negative, FN=false negative, FP=false positive, TP=true positive. Sensitivity = .43 Specificity = .95 Agreement percentage = .73

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